Equilibrium dec 8 file 1

Thursday, December 8, 2022 6:09 PM

Q→ find K_c?

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$$

If 40% of NH_3 dissociates at Eq^m and $\boxed{4 \text{ moles}}$ of NH_3 added at $t=0$ in 2L container.

Solⁿ:- Degree of Dissociation of NH_3 $(\alpha_{NH_3}) = \frac{\%\,diss}{100} = \frac{40}{100} = 0.4$

α_{NH_3} → part of 1 mole dissociated

$1 \rightarrow 0.4$
$2 \rightarrow 2 \times 0.4$
$3 \rightarrow 3 \times 0.4$
$4 \rightarrow \boxed{4 \times 0.4}$ → moles of NH_3 dissociated

$$2NH_3(g) \rightleftharpoons 1N_2(g) + 3H_2(g)$$

	$2NH_3(g)$	$1N_2(g)$	$3H_2(g)$
$t=0$	4	0	0
at Eq^m	$4(1-\alpha)$ $4-4\alpha$ $(4-4\times0.4)$ 2.4 moles	$\boxed{(4\alpha)\times\frac{1}{2}}$ 0.8 moles	$\frac{3}{2}\times4\alpha$ 2.4 moles

→ 2L cont

$$\boxed{K_c = \frac{[H_2]^3_{eq}[N_2]_{eq}}{[NH_3]^2_{eq}}}$$

Conc. at Eq^m ⇒ $[NH_3]_{eq} = \frac{2.4}{2}$ M $[H_2]_{eq} = \frac{2.4}{2}$

$[N_2]_{eq} = \frac{0.8}{2}$ M

Q→ $2A_{(g)} \rightleftharpoons 2B_{(g)} + 3C_{(g)}$

$t=0$ 3 mole 0 0

$\boxed{\alpha_A \text{ at } Eq^m = 0.2}$ find moles of each species at Eq^m.

Solⁿ:- $2A_{(g)} \rightleftharpoons 2B_{(g)} + 3C_{(g)}$

$t=0$ 3 mole 0 0

at Eq^m $3(1-0.2)$ 0.6 $\frac{3}{2}\times0.6$
$3-0.6$

Q→ N_2O_4 is 25% dissociated at 37°C, 1 atm.
find i) K_p
ii) % dissociation of N_2O_4 at $\boxed{0.1 \text{ atm}}$ & 37°C.

N_2O
NO
$\boxed{N_2O_3}$ → Blue solid/Liq
N_2O_4
NO_2 → only this is colored (Brown) gas
N_2O_5
→ Rest all are Colorless

Solⁿ
Colorless Brown gas
$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

$t=0$ a mole 0

at Eq^m $a-(a\times0.25)$, $a(1-0.25)$, $0.75a$ $2a(0.25)$, $0.5a$ → Total moles at Eq^m $= 0.75a + 0.5a = 1.25a$

$$K_p = \frac{(P_{NO_2})^2}{P_{N_2O_4}} = \frac{\left(\frac{0.5a}{1.25a}\times1\right)^2}{\left(\frac{0.75a}{1.25a}\times1\right)}$$

$P_{NO_2} = X_{NO_2} \times \boxed{P_T}$ → 1 atm

$= \frac{0.5a}{1.25a}\times1$

$$K_p = \frac{\frac{0.5\times0.5}{\cancel{1.25\times1.25}}}{\frac{0.75}{\cancel{1.25}}} = \frac{0.5\times0.5}{1.25\times0.75} = \frac{100}{375}$$

(ii) $N_2O_4 \rightleftharpoons 2NO_2$ Total
at Eq^m $\boxed{a-a\alpha \quad 2a\alpha}$ → $a+a\alpha$

$\boxed{K_p \text{ remains same}}$

$$K_p = \frac{100}{375} = \frac{(P_{NO_2})^2}{P_{N_2O_4}} = \frac{\left(\frac{2a\alpha}{a+a\alpha}\times0.1\right)^2}{\left(\frac{a-a\alpha}{a+a\alpha}\times0.1\right)}$$

$\alpha = ✓$
$\%\,diss = \alpha \times 100$

$\boxed{Ans = 63.2\%}$

Q→ $2A(g) \rightleftharpoons B(g) + C(g)$
at Eq^m, 500 ml of mix of Gas contains 300 ml of A & B.
find K_p at 300K, 10 atm?

Solⁿ:- $PV = nRT$
$\boxed{P, T = \text{const}}$ → for every Gas
$V \propto n$

for any gas: $\boxed{\begin{array}{l}\text{Vol fraction} = \text{mole fraction} \\ \text{Vol \%} = \text{mole \%}\end{array}}$

$$2A(g) \rightleftharpoons B(g) + C(g)$$

at Eq^m: $\underbrace{A + B}_{300\,ml}$ 200 ml
A: 100 ml B: 200 ml

Vol. fraction of A $= \frac{100}{500} = \frac{1}{5} = X_A$

$\boxed{X_B = \frac{2}{5} = X_C}$

$$K_p = \frac{P_B \times P_C}{(P_A)^2} = \frac{(\frac{2}{5}\times10)^2}{(\frac{1}{5}\times10)^2} = 4$$

Relation of Vapour density and Degree of Diss (α)

$$\boxed{V.D = \frac{\text{Molar mass}}{2}}$$

$$\boxed{\alpha = \frac{D-d}{d(n-1)}} \rightarrow \alpha = \frac{M_T - M_0}{M_0(n-1)}$$

D = V.D of Reactant undergoing Dissociatⁿ
$= \frac{\text{Molar mass of Reactant}}{2}$ → $\frac{M_{Theoretical}}{2} \Rightarrow \frac{M_T}{2}$

n ⇒ no. of products per mole of reactant.

d = V.D of Gaseous mix at Eq^m
$= \frac{\text{Molar mass of mix}}{2}$ or $\frac{M_{average}}{2}$

$$\boxed{d = \frac{M_{mix}}{2} \text{ or } \frac{M_{av}}{2}} \rightarrow \frac{M_{observed}}{2} \text{ or } \frac{M_0}{2}$$

eg:- $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$
$n = \frac{1+3}{2} = 2$

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
$n = 2$

Q→ find % dissociation of PCl_5 at 300K if observed V.d of mix at Eq^m is 60.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

Solⁿ
$$\alpha = \frac{\left(\frac{208.5}{2}\right) - 60}{60(2-1)} = \frac{104.25-60}{60} = 0.7375$$

$\boxed{\%\,diss = 73.75\%}$

Note:- • V.d of mix & density of mix are different
• If density of mix (ρ_{mix}) at Eq^m is given, then use following formula

$$PM_{mix} = \rho_{mix}RT$$

$$\boxed{V.d \text{ of mix} = \frac{M_{mix}}{2} = \frac{\rho_{mix}RT}{2P}}$$

H.W
$\boxed{\text{Solve Example 2 (Pg-129)}}$

V.imp
Concept of Reaction Quotient (Q)

→ Expression written Exactly like Eq^m const But values of conc. of species are taken at Non-Eq^m point.

⇒ if $Q < K_{eq}$; Forward shift will be there to achieve Eq^m. $[R_f > R_b]$
⇒ if $Q > K_{eq}$; Backward " " " " " " $[R_b > R_f]$
⇒ if $Q = K_{eq}$; Rxⁿ is already at Eq^m; $R_f = R_b$

Q→ If 1 mole Each of $A_{(g)}, B_{(g)}, C_{(g)}, D_{(g)}$ at added in 2 L container, 300K. If following Rxⁿ takes place:- $A(g) + B(g) \rightleftharpoons C(g) + D(g)$; $K_c = \frac{1}{16}$

Find Eq^m conc. of each species.

Solⁿ:-
$$A(g) + B(g) \rightleftharpoons C(g) + D(g)$$

	A	B	C	D
$t=0$	1 mole	1 mole	1 mole	1 mole
Conc at $t=0$	$\frac{1}{2}$M	$\frac{1}{2}$M	$\frac{1}{2}$M	$\frac{1}{2}$M

$$Q_{t=0} = \frac{[D][C]}{[A][B]} = \frac{\frac{1}{2}\times\frac{1}{2}}{\frac{1}{2}\times\frac{1}{2}} = 1 > K_c$$

So, $(R_B > R_f)$, Backward Shift to achieve Eq^m

H.W Solve
Pg 128 Q→125
Pg-127, Q→109

$$A + B \rightleftharpoons C + D$$

	A	B	C	D
at Eq^m	$1+x$	$1+x$	$1-x$	$1-x$
Conc. at Eq^m	$\frac{1+x}{2}$	$\frac{1+x}{2}$	$\frac{1-x}{2}$	$\frac{1-x}{2}$

$$K_c = \frac{1}{16} = \frac{\left(\frac{1-x}{2}\right)^2}{\left(\frac{1+x}{2}\right)^2}$$

$$\boxed{\pm\frac{1}{4} = \frac{1-x}{1+x}}$$